KINEMATIC ANALYSIS OF PACE BOWLING ACTION IN RELATION TO VARIATIONS IN BOWLING TECHNIQUE IN CRICKET

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Chapter-I

INTRODUCTION

The fastest bowlers in the world attract large crowds due to the intensity they bring to the game. Mastery of the most appropriate technique, together with other aspects of bowling development are all essential if one is to reach full potential. The factors which improve bowling velocity without increasing the threat of injury will better equip and prepare bowlers to acquire the art of fast bowling, and for coaches to identify and spot-on flaws in the bowling action. While the rewards of success are easily identified, the stresses and strains placed on the body during fast bowling are a major concern to the bowler. The physical demands on the bowler are ever increasing. Typically the county and international standard bowler will bowl up to ten or more six ball overs a day, between four and five days a week, for as many as forty weeks a year. On average, with each delivery producing a peak ground reaction force of 5 BW and a loading rate of277 BW S·l, when combined with training sessions, running and even fielding, the forces on the fast-medium bowler are very strenuous. Elliott et al e (1992) suggested that a possible reason for the high incidence of injuries amongst bowlers was that they were being forced to train longer, harder and earlier in life to excel in their chosen sport. They suggested that the sheer number of repetitious hours of practice might produce gradual deterioration in specific parts of the body. It is, therefore, not surprising that physicians are diagnosing an increased number of overuse injuries. Bell (1992) stated that the combination of incorrect technique, poor preparation, overuse and clinical features all increased the risk of injury to the bowler. For an impact sport, this means large forces are transmitted through a variety of body tissues via the foot, ankle, knee, hip and various joints of the back. Often concurrently with these high loads, the trunk is flexing laterally and rotating in an effort to maximize the speed of the bowling-shoulder. A range of mechanical variables have been commonly linked with lower back injury and include, but are not delimited to: shoulder alignment counter rotation (CR), hip-shoulder alignment separation angle (SA), front knee flexion (KF) and trunk lateral flexion (TLF) (Foster et al., 1989; Burnett et al., 1995; Ranson et al., 2005).

Statement of the problem

The purpose of the study is to analyze the relationship among the categories of pace bowling velocity and selected kinematic variables in cricket bowling.

Delimitations

The study will be delimited to the following aspects.

1) The study will be delimited to 10 U-19 pace bowlers.

2) The subjects of the study will be selected from Uttar Pradesh.

3) The subject's age will be ranged between 16 to 19 years.

4) Selected kinematic variables will be as follows:

a. Approach Run
b. Knee angle at Back -foot strike
c. Knee angle at front-foot strike
d. Front Knee angle at ball release
e. Ball Release Height
f. Trunk lateral flexion
G. Elbow angle of bowling arm

LIMITATIONS

1. Non-availability of sophisticated instruments
2. There will be no control over their habit, diet and motivation.
3. There will be no control over environmental factors.
4. Their sociological aspects and their day-to-day activities will not be considered.

Hypothesis

It is hypothesized that

H_1 There will be significant relationship among selected kinematic variable and pace bowling velocity categories.

H_1 There will be significant relation between Trunk lateral flexion and variations of bowling speed

Definition and explanation of term

Biomechanical analysis

Biomechanical analysis is the detailed study of human motion in relation to the conventional law of classic physics. For the purpose of the angles at selected joints and height of centre of gravity represents the biomechanical variables.

Pace Bowling

Fast bowling, sometimes known as pace bowling, is one of the two main approaches to bowling in the sport of cricket. The other is spin bowling. Practitioners are usually known as fast bowlers, fast men, pace bowlers, quicks, or pacemen, although sometimes the label refers to the specific fast bowling technique the bowler prefers, such as swing bowler or seam bowler. (Encylopedia-2015).

Kinematics

Kinematics is the branch of classical mechanics that describes the motion of points, bodies (objects) and systems of bodies (groups of objects) without consideration of the forces that cause it. Kinematics is description of motion and includes consideration of time, displacement, velocity, acceleration and space factors of a system's motion.(R.T.Floyd.et al,2012).

Significance of the study

1. The results of the study will enlighten the technique of the junior pace bowlers and their fitness

2. It would enhance the awareness during coaching the players.

3. The research will be helpful to examine the effects on Kinematic variables and improvement on bowling speed.

4. The result of the study may provide latent justifications for severe modifications in technique.

5. The revealed facts would contribute to the physical educationists, sports scientists and cricket scientists to enhance their knowledge about the junior level pace bowlers especially who belongs to Uttar Pradesh.

Chapter-II

REVIEW OF RELATED LITERATURE

The review of related literature relating to the study on the difference as well as relationship of anthropometric and biomechanical variable of various games and sports as the scholar has glanced from the online journals available on the internet is enumerated below.

Kane Middleton, Poonam Chauhan, Bruce Elliott and Jacqueline Alderson, 2009 examined the velocity dependence of shoulder alignment counter rotation, maximum hip-shoulder separation angle, maximum front knee flexion angle and maximum trunk lateral flexion. High-performance fast bowlers (n=17) were required to bowl multiple deliveries in a fast, normal and slower ball category. No statistical association was found between bowling velocity and maximum shoulder counter rotation or knee flexion. Significant associations were found between ball release velocity and trunk lateral flexion and maximum hip-shoulder separation angle. Significant differences were found between the bowling categories for separation angle and knee flexion. A regression analysis showed that trunk lateral flexion and separation angle only accounted for 11% of the ball velocity variance, for the normal delivery (31.3 ms-1).

Paul S. Glazier, Giorgos P. Paradisis & Stephen-Mark Cooper analyzed Anthropometric and kinematic influences on release speed in men's fast-medium bowling. The main aim of this study was to identify significant relationships between selected anthropometric and kinematic variables and ball release speed. Nine collegiate fast-medium bowlers (mean - s : age 21.0 - 0.9 years, body mass 77.2 - 8.1 kg, height 1.83 - 0.1 m) were filmed and reconstructed three-dimensionally. Ball release speeds were measured by a previously validated Speedchek™ Personal Sports Radar (Tribar Industries, Canada). Relationships betweenselected anthropometric variablesand ball release speed and between kinematic variables and ball release speed were investigated using Pearson's product-moment correlation coefficients (r). A significant relationship was found between the horizontal velocity during the pre-delivery stride (r = 0.728, $P \ll 0.05$) and ball release speed (31.5 - 1.9 m·s -1). We believe that the high correlation was due to the bowlers using techniques that allowed them to contribute more of the horizontal velocity created during the run-up to ball release speed. We also found that the angular velocity (40.6 - 3.4 rad·s -1) of the right humerus had a low correlation (r = 0.358, $P > 0.05$) with ball release speed. Although the action of the

wrist was not analysed because of an inadequate frame rate, we found high correlations between ball release speed and shoulder-wrist length (661 - 31 mm; r = 0.626, P ≪ 0.05) and ball release speed and total arm length (860 - 36 mm; r = 0.583, P ≪ 0.05). We conclude that the variance in release speed within this group may be accounted for by the difference in radial length between the axis of rotation at the glenohumeral joint and the release point.

Chelly, MS, Hermassi, S, and Shephard, RJ. investigated relationships between peak power (PP) as measured by upper limb (PP_{UL}) and lower limb (PP_{LL}) force-velocity tests, maximal upper limb force assessed by 1 repetition maximum bench press ($1RM_{BP}$), and pullover ($1RM_{PO}$) exercises, estimates of local muscle volume and 3-step running handball throwing velocity ($T_{3\text{-}Steps}$). Fourteen male handball players volunteered for the investigation (age: 19.6 ± 0.6 years; body mass: 86.7 ± 12.9 kg; and height 1.87 ± 0.07 m). Lower and upper limb force-velocity tests were performed on appropriately modified forms of a Monark cycle ergometer, with measurement of PP_{UL} and PP_{LL}, and the corresponding respective maximal forces (F_{0UL} and F_{0LL}) and velocities (V_{0UL} and V_{0LL}). $T_{3\text{-}Steps}$ was assessed using a radar Stalker ATS system™. Muscle volumes of the upper and lower limbs were estimated with a standard anthropometric kit. $T_{3\text{-}Steps}$ was closely related to absolute PP_{UL} and toF_{0UL} ($r = 0.69$, $p < 0.01$ for both relationships). $T_{3\text{-}Steps}$ was also moderately related to $1RM_{BP}$ and $1RM_{PO}$ ($r = 0.56$, $p < 0.05$; $r = 0.55$, $p < 0.05$ respectively), and to PP_{LL} and F_{0LL}($r = 0.56$, $p < 0.05$; $r = 0.62$, $p < 0.05$, respectively). When PP_{LL} was expressed per unit of limb muscle volume, the relationship with $T_{3\text{-}Steps}$ disappeared. This suggests the importance of muscle volume to performance in throwing events. Force-velocity data may prove useful in regulating conditioning and rehabilitation programs for handball players. Our results also highlight the contribution of both the lower and the upper limbs to handball throwing velocity, suggesting the need for coaches to include upper and lower limb strength and power programs when improving the throwing velocity of handball players.

Ranson, C.A. et al, 2009 titled the effect of coaching intervention on elite fast bowling technique over a two year period where 14 elite young fast bowlers were measured using an 18 camera Vicon Motion Analysis system before and after two-year coaching interventions that addressed specific element(s) of fast bowling technique. This study has clearly shown that specific aspects of fast bowling technique can change in elite players over a two year period and this may be attributed to coaching intervention. However, although factors related to shoulder alignment at the beginning of the fast bowling delivery stride were changed, desired improvements in trunk posture and knee mechanics later in bowling action i.e. during FFC, were not able to be achieved in this group.

Peter Worthington, 2009 in a study titled the effect of individualised coaching interventions on elite young fast bowlers‘ technique where 14 elite young fast bowlers were measured using an 18 camera Vicon Motion Analysis System. Subjects were tested before and after a two year coaching intervention period, during which subject-specific coaching interventions were provided. Mann-Whitney tests were used to identify significant differences in the change in the selected kinematics between those bowlers who were coached or un-coached

on each specific aspect. Coached athletes demonstrated a significant change in shoulder alignment at back foot contact (more side-on, P = 0.002) and shoulder counter-rotation (decreased, P = 0.001) relative to un-coached athletes. There was no difference in the amount of change in flexion angles of the front or back knee or lower trunk side-flexion between those who received coaching intervention and those that did not. This study shows that specific aspects of fast bowling technique in elite players can change over a two year period and may be attributed to coaching intervention.

Ranson, C.A. et al,2008 in Journal of Sports Science titled The relationship between bowling action classification and three-dimensional lower trunk motion in fast bowlers in cricket where 50 fast bowlers were involved in Three-dimensional kinematic and Lower back injuries, specifically lumbar stress fractures, account for the most lost playing time in professional cricket. And he concluded A very high percentage of fast bowlers in this, and other studies, have been classified as having a mixed bowling action whilst no bowlers in this study were classified as front-on. Further, fast bowling action characteristics currently used to identify potentially dangerous action types do not appear to be directly related to the likely pathomechanics of contra lateral side lumbar stress injuries.

Hurrion & Harmer,2002, titled The Fast-Medium Bowler ,Sports Biomechanics and Technical Analysis Model where sixty fast-medium bowlers playing England age groups U13, U14, U15, U17 and U19 were filmed and analyzed during competitive play. Each bowler was filmed from three angles, side-on, front-on and back view. Technical and biomechanical analysis were made for each bowler using the following phases, Pre Delivery Stride (gather),Mid bound, Back Foot Contact, Mid position // Front foot contact, Release and Follow Through. The most common biomechanical and technical faults were identified. This data was used to develop a technical model of sports biomechanics and analysis for all fast-medium bowlers. The authors suggest that if the seven most common technical faults can be eradicated then the young fast-medium bowler would reduce the risk of injury and fully maximize his / her potential.

Chapter-III

PROCEDURE

Sources of data

For the purpose of the study 10 male junior pace bowlers of Uttar Pradesh will be the subject of this study. Their age ranges 14-19 years. The subjects will be selected from Uttar Pradesh Cricket clubs at random who at least played for state level.

Pre-Testing

Prior to the beginning of the experimental protocol subjects standing heights and weights will be measured by using stadiometer, weighing machine and history of injury information will be taken from the bowlers.

Experimental Protocol

Prior to the collection of the dynamic bowling trials, participants will go for their personal warm-up. Participants will bowl over the wicket and were instructed to aim to hit a target area shown in figure no. 1 as viewed from the bowler's end. Each participant will bowl 2 sets of six consecutive deliveries (an over), with a short break between each set in an attempt to replicate match conditions. Within each over, participants will bowl four deliveries at their 'normal' match pace, while one delivery will be bowled at 'very fast' pace, that is; the bowler's fastest possible delivery speed, and the other a 'slower' delivery. The delivery order will be randomly allocated.

TLF will be calculated as the maximum relative angle between the vertical trunk axis and the horizontal pelvic axis in the frontal plane during the delivery action. Means of the three 'very fast', three 'slower' and 6 'normal' deliveries from the 1st and 2nd overs of each bowler will be used for analysis.

Data Collection

Filming Procedures

Six Digital HD video cameras, mounted on tripods, filmed each bowler during the bowling spells. The cameras will be positioned in such a place from where the locus of movement of the major joint markings on the body will be central to the video graphic plane of

all cameras, and such that at least two cameras may track these land marks throughout the delivery stride. The experimental configuration is shown in figure 1.

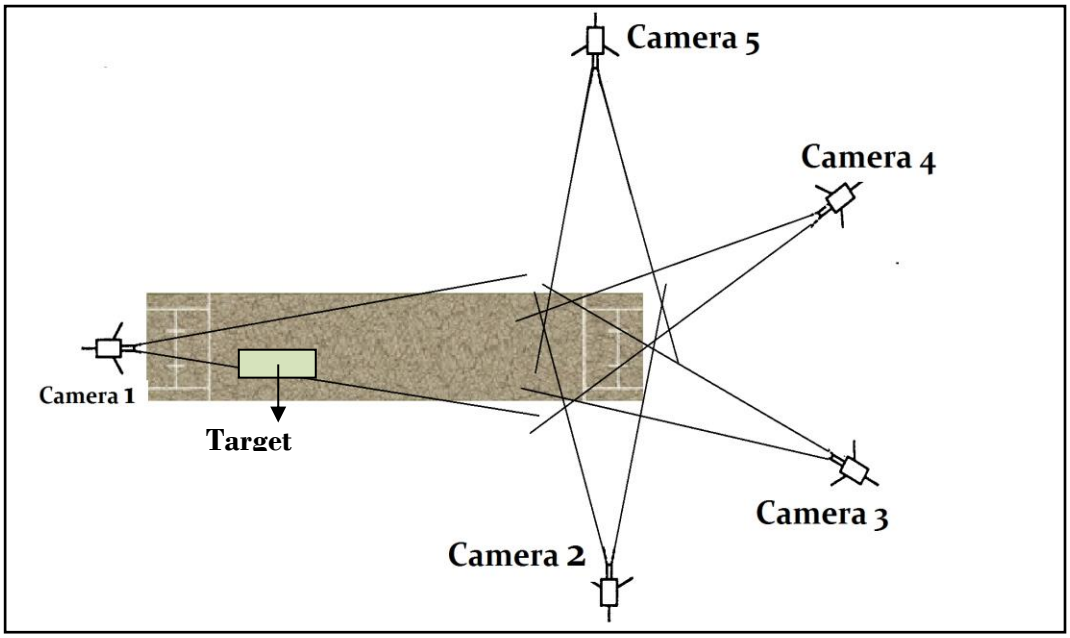

Figure 1: Camera configuration during testing

The balls of each bowler's during their spell which will be delivered at the target area (Figure 1), will be recorded on film for analyses [Burnett, A., Elliott, B. and Marshall, R. (1995)]

The stick figures will be developed by using segmentation method suggested by HAY. J.G, (1978) and the ball release speed of each delivery bowled will be analyzed by using the Radar gun /Kenovea- 8.24 software.

Kinematic Variables

a. Approach Run
b. Knee angle at Back -foot strike
c. Knee angle at front-foot strike
d. Front Knee angle at ball release
e. Ball Release Height
f. Trunk lateral flexion (TLF)
G. Elbow angle of bowling arm

Reliability of data

The reliability of the data will be established through test and retest method. 05 junior pace bowlers will be randomly selected from the local club and filmed each bowler during the bowling spells. The video will be analysed twice for test and retest to establish the reliability of the obtained kinematics values.

Analytical Procedure to be used

In order to test the homogeneity of the subject's descriptive statistics will be applied, Pearson's product moment correlations will be calculated and to be used to identify associations between each dependent variable and ball velocity within each of the three velocity categories.. For testing hypothesis the level of significance will be set at 0.05.

KEYWORDS:

KINEMATIC ANALYSIS, PACE BOWLING ACTION, VARIATIONS, BOWLING TECHNIQUE, CRICKET

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